Guidance for Reducing Drinking Water Lead Levels in New Buildings

Technical Information Paper No. 31-010-0911

PURPOSE. To provide guidance and recommend actions to reduce elevated lead levels in drinking water in new buildings prior to occupancy.

REFERENCES. See Appendix for a list of reference information.

INTRODUCTION

Overview

Safe and acceptable drinking water is critical to ensuring public health and mission success. Several recent and documented incidents of elevated levels of lead in the drinking water of new building plumbing systems have highlighted the potential health risks posed by exposure to elevated lead levels and the need to ensure safe drinking water supplies in new buildings (references 1–3). This information paper is intended to minimize the health risks associated with elevated lead levels in drinking water in new buildings prior to occupancy.

Regulatory Control of Lead in Drinking Water

There are no Federal requirements for controlling lead in drinking water that apply specifically to newly constructed buildings. However, three provisions of the Safe Drinking Water Act (SDWA): the 1986 SDWA lead ban; the 1988 Lead Contamination and Control Act (LCCA); and the 1991 Lead and Copper Rule (LCR), were implemented to control lead and copper in drinking water distribution systems. The SDWA lead ban set limits on how much lead content can be found in materials used in construction of water system distribution and building plumbing systems by defining various "lead free" materials. Lead free solder and flux cannot contain more than 0.2 percent lead by weight. Lead-free fixtures or fittings (e.g., faucets, valves, and pressure-reducing devices) cannot contain more than 8.0 percent lead by weight. The LCCA only recommended controlling lead in schools and child care centers. The LCR was intended to identify distribution system-wide corrosion problems by targeting older homes containing lead solder and lead pipe that are at a higher risk for leaching lead. While the 1986 SDWA lead ban did minimize sources of lead in plumbing systems, research conducted since the ban took effect shows that fixtures and fittings containing 8.0 percent lead, primarily those made from brass, can still leach significant amounts of lead into drinking water (references 4–7).

Sources of Lead in New Building Plumbing Systems

Brass plumbing components, and brass shavings and particulates are the two main sources of lead in new building plumbing systems. Brass plumbing components include faucets, shut-off valves, compression fittings, Y-strainers (or similar basket and V-type strainers), and pressure reducing valves. Brass shavings and particulates can be found in new building plumbing systems as a result of the plumbing component manufacturing process and typical installation procedures (e.g., cutting, deburring). These particulates can be captured in screens or strainers in many plumbing components (e.g., faucet aerators, water fountain screens, Y-strainers). Corrosion of these plumbing components and particulates results in lead leaching into the drinking water. This can be a common occurrence in new buildings (references 1–3). New brass plumbing components have been shown to leach elevated levels of lead immediately after installation, usually followed by a general decline in levels after repeated exposure to water (reference 2). Research attributes this to contact of drinking water with unpassivated brass components. Unpassivated plumbing components have not yet established a protective film between the component and the drinking water. The establishment of that protective film is a process called passivation and is achieved through repeated exposure to the drinking water. A protective film usually consists of less soluble metal hydroxides and metal carbonates, or a layer of calcium carbonate, on interior plumbing component surfaces in contact with the drinking water. The protective film effectively minimizes the dissolution, or leaching, of lead (and other metals including copper) into the drinking water (reference 3).

REDUCING LEAD IN DRINKING WATER IN NEW BUILDINGS

Establishing a Goal for Acceptable Lead Levels

The first step in reducing drinking water lead levels in new buildings is to establish a goal for permissible levels of lead. The goal should be based on minimizing the health risks associated with exposure to elevated lead levels in drinking water. The goal should also be realistic. Corrosion of building plumbing and leaching of metals, including lead, from plumbing materials into drinking water will always occur to some degree (ideally, the amount of leaching would be so minimal as to be nondetectable). It is recommended that the goal for permissible levels of lead be based on the same compliance determination process established for the LCR. Compliance with the LCR requires 90 percent of the lead samples collected to have less than or equal to 0.015 milligrams per liter (mg/L) lead, or parts per million (ppm). Therefore, the goal for determining acceptable drinking water lead levels in new buildings should be a passing rate of 90 percent. If at least 90 percent of the sample locations have lead results less than or equal to 0.015 mg/L, then the health risks associated with lead in drinking water

in the new building can be considered minimized. This goal can typically be achieved through effective flushing of the building plumbing system.

Flushing the Plumbing System

Flushing Plan Objectives

The objectives of a flushing plan are two-fold: removing lead-containing (i.e., brass) particulates in the plumbing system, and minimizing corrosion of lead-containing plumbing components. This is accomplished by implementing a flushing plan consisting of an initial, high-rate flush to remove any lead-containing particles, followed by a low-rate flush to induce formation of a protective film and reduce corrosion of lead-containing plumbing components. With these objectives in mind, an effective flushing plan can be developed.

Elements of a Flushing Plan

Overview

The flushing plan should consist of the following items: (1) identification of flushing and sampling locations within the building; (2) flushing procedures; (3) sampling and testing procedures; and (4) follow-up actions for locations continuing to have elevated lead levels (i.e., greater than 0.015 mg/L).

Identification of Flushing and Sampling Locations

Ideally, all faucets in a new building should be included in the flushing plan to ensure the entire plumbing system is flushed and the objectives are met. However, this may not be feasible, especially for large buildings with numerous faucets or situations where resources are limited. In that event, specific faucets should be identified as flushing and sampling locations using the following guidelines:

- Obtain building plumbing schematics. These are critical for choosing faucets that will ensure the maximum amount of plumbing will be flushed.

- Using building plumbing schematics, choose as many faucets as resources will allow. At a minimum choose at least 5–10 percent of the total number of taps in the new building. For multi-story buildings choose several faucets on each floor.

- Choose enough faucets to provide adequate physical coverage of the entire building. When choosing faucets on floors in multi-story buildings, ensure some

faucets are located as far away from the vertical pipe risers that carry drinking water from a lower floor to a higher floor. This ensures the maximum amount of plumbing per floor is flushed. In some cases there may be multiple pipe risers serving a floor. In those cases, it's best to choose faucets located between the risers to maximize the amount of plumbing flushed. For a large single story building be sure to include faucets that are far away from the building's service connection. The service connection is the pipe connecting the building water supply to a distribution system main pipe. Figure 1 provides examples of acceptable faucet locations to use as flushing and sampling locations for the scenarios just described.

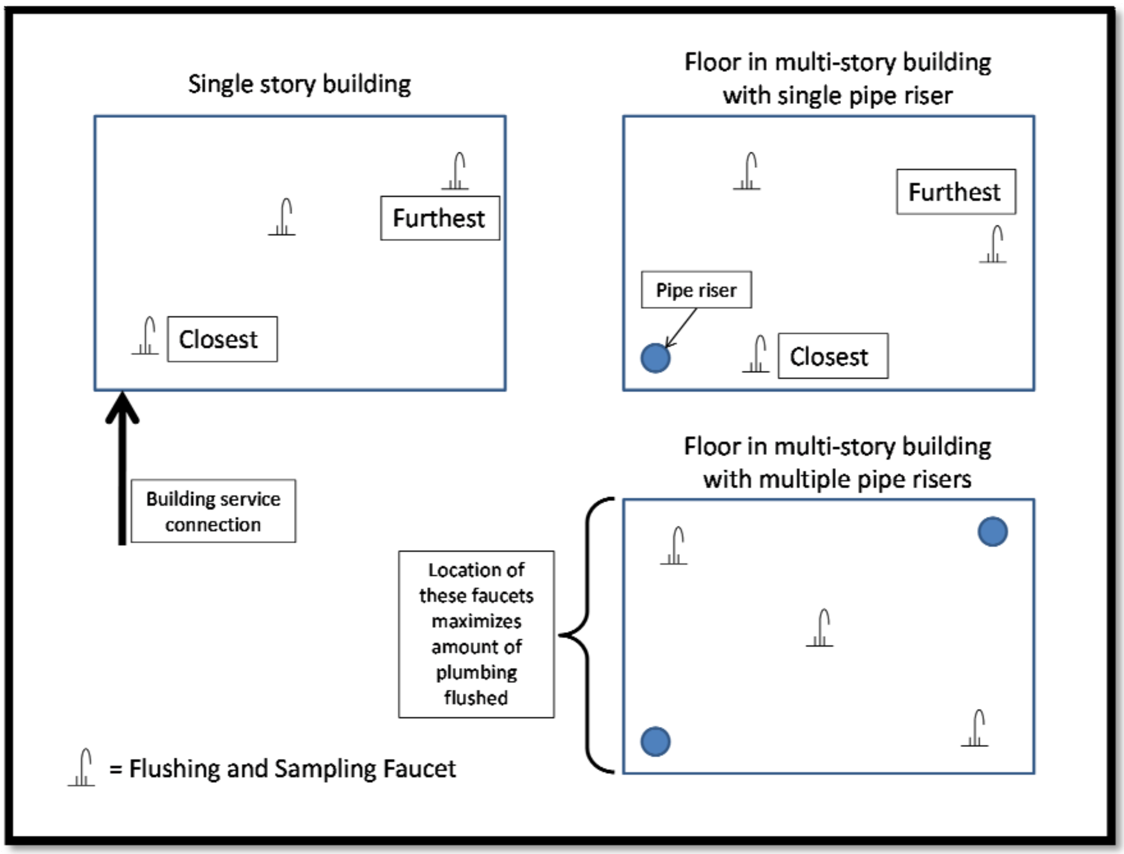

Figure 1. Examples of Flushing and Sampling Faucet Locations

- Choose "high-risk" faucets. Choose faucets that are most likely to be used for drinking, food preparation, or are located in areas where children may use them. Examples of "high-risk" faucets include faucets in kitchen or break room areas, cafeteria and food preparation areas, pediatric wings, or child day care facilities or areas within the building.

Flushing Procedure

For a multi-story building, start the flushing procedure at the floor where the service connection enters the building. This is usually the basement or first floor. For each floor or single-story building, flush the selected faucets in order from closest to furthest from the water "source" (service connection or vertical pipe riser) using the following procedure. Flushing in a random, or different order, may not effectively remove particulates and may only disperse them into other parts of the plumbing system. Figure 2 shows examples of flushing orders.

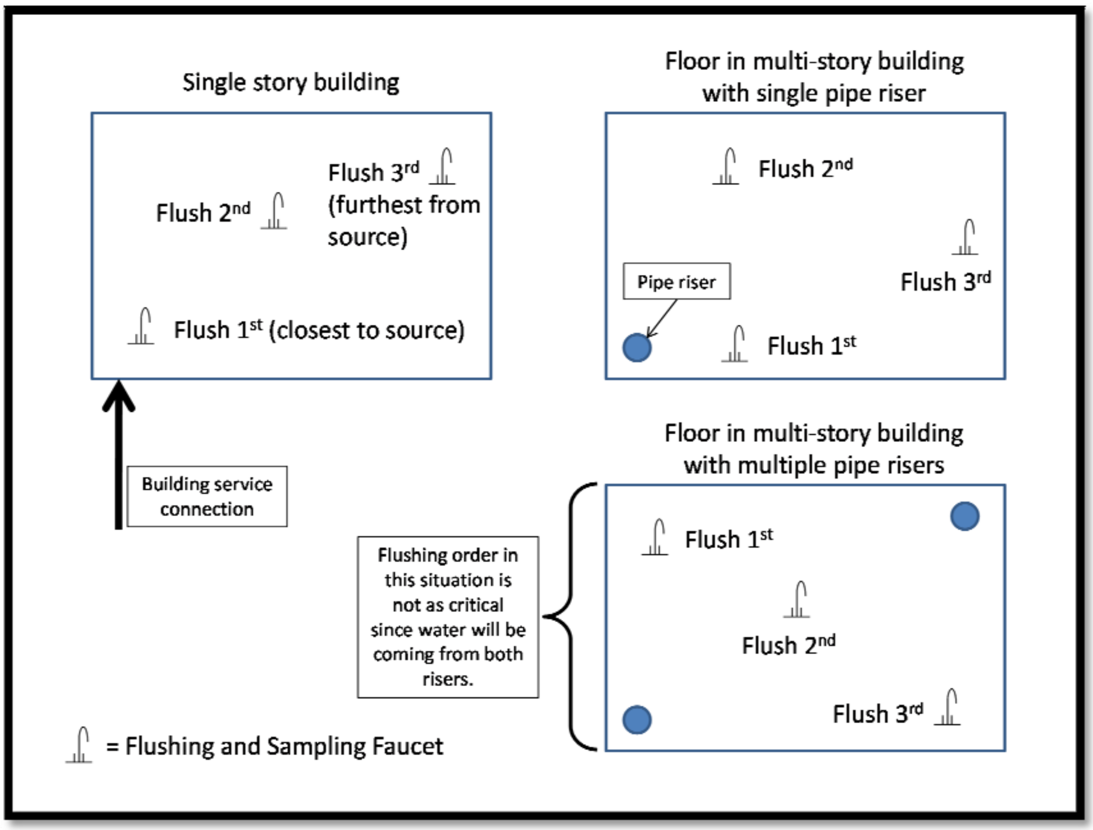

Figure 2. Example Flushing Orders

Flush the building plumbing using the following guidance:

- Remove faucet aerators. Clean any debris or particles from the aerator if visibly present.

- With aerators removed, fully open the cold water tap on each faucet on a floor (for a multi-story building), or area within a single story building, and flush at a

high rate for 10 minutes. This is intended to remove lead-containing particles (e.g., brass shavings and particulates) in the plumbing.

- After the 10-minute high-rate flush, reaffix faucet aerators.

- With aerators reaffixed, open faucets just enough to flow at a slow trickle. Allow the faucet to flow at this low rate for at least 24 hours, preferably up to 72 hours. This is intended to establish a protective film (i.e., induce passivation) and minimize lead leaching. The longer the low-rate flow is allowed to continue, the greater the likelihood that a protective film will be established.

- While the faucets are flowing at the low rate, proceed to the next floor, for a multi-story building, or, if necessary, proceed to the next area of a single-story building (moving farther away from the building service connection).

- Repeat until all faucets chosen have been flushed.

Sampling and Testing Procedures

Technical Support and Resources

Sampling and testing for lead involves specific sample collection, handling, and analytical requirements. Many local and regional drinking water laboratories can provide sampling containers, sample collection instructions, and provide analytical support. Use a laboratory that is state-certified for lead analysis in drinking water. To find a certified, local laboratory, visit the U.S. Environmental Protection Agency's (USEPA's) laboratory certification website and click on the state's online listing link: http://water.epa.gov/scitech/drinkingwater/labcert/statecertification.cfm. The U.S. Army for Public Health (USAPHC) also provides sampling and analytical support. Contact the Water Supply Management Program at 410-436-3919 (DSN 584-3919) or email: water.supply@amedd.army.mil for assistance.

Lead Sampling Procedure

- After the low-rate flushing is complete, let the faucets sit unused for at least 6 hours before collecting samples. It's usually most convenient to allow the water to sit unused overnight. This stagnation period is intended to characterize a worst-case lead exposure scenario to consumers by allowing the water to contact brass plumbing components for an extended period.

- For both multi-story and single-story buildings, start at the faucet nearest the building's service connection.

- Collect a 1 liter “first draw” sample. Place a laboratory supplied, 1 liter sample bottle under the faucet. Gently open the cold water faucet and fill the sample bottle. This “first draw” represents water that sat unused in the plumbing system (i.e., a non-flushed sample). Therefore, it is essential to begin sampling at the faucet closest to the building’s service connection for both multi-story and single-story buildings. This ensures water that sat unused is not flushed out by sampling other taps further away from the service connection.

- For a multi-story building, continue to the next floor and begin collecting samples at faucets located nearest to the vertical pipe risers then moving further away. For a single-story building, continue to sample faucets moving further away from the service connection.

Data Analysis

- Calculate the percentage of samples with lead results equal to or less than 0.015 mg/L. If 90 percent or more of the samples are less than or equal to 0.015 mg/L, then the building should be considered to have acceptable drinking water lead levels. If the passing rate is less than 90 percent, conduct a second round of flushing and subsequent lead sampling of those faucets with lead results greater than 0.015 mg/L. If during the first round of flushing the low-rate flush was conducted for 24 hours, consider conducting it for a longer period of time (48–72 hours). Conducting a longer, low-rate flush enhances the establishment of a protective film. If 90 percent or more of the samples from both the first and second rounds of flushing are less than or equal to 0.015 mg/L, then the building should be considered to have acceptable drinking water lead levels. Figures 3 and 4 show examples on calculating the passing rate. Figure 3 shows an example of a building with an acceptable passing rate after the first round of flushing (90 percent of samples are less than or equal to 0.015 mg/L – a 90 percent passing rate). Figure 4 shows an example of a building that only achieved a 70 percent passing rate after the first round of flushing (only 7 out of 10 locations had lead results less than or equal to 0.015 mg/L). But, after the second round of flushing, the building achieved a 90 percent passing rate (9 out of 10 locations had lead results less than or equal to 0.015 mg/L).

- If after the second round of flushing the passing rate is still less than 90 percent, identify the major source(s) of lead for those faucets with lead results greater than 0.015 mg/L and take the remedial actions discussed in the next sections.

- If the 90-percent passing rate is achieved after the first round of flushing, and there are sampling locations with lead results above 0.015 mg/L, consider taking actions to reduce lead levels at those specific locations. Conduct a second flushing event. If lead results are still greater than 0.015 mg/L at those locations, then consider taking actions to identify and remediate the lead sources.

- If the 90-percent passing rate is achieved after the second round of flushing, and there are still sampling locations with lead results above 0.015 mg/L, then consider taking actions to identify and remediate the lead sources at those locations.

This is a 90 percent passing rate. Nine out of 10 samples were ≤ 0.015 mg/L.

Flushing and Sampling Location	1st Flush Lead Result (mg/L)
Faucet B1 – 1st Floor	0.023
Faucet G3 – 3rd Floor	0.015
Faucet E2 – 2nd Floor	0.009
Faucet K3 – 3rd Floor	0.008
Faucet H3 – 3rd Floor	0.005
Faucet F2 – 2nd Floor	0.005
Faucet A1 – 1st Floor	Not Detected
Faucet C1 – 1st Floor	Not Detected
Faucet D2 – 2nd Floor	Not Detected
Faucet L3 – 3rd Floor	Not Detected

Consider conducting a second flush at this location. If lead levels are still > 0.015 mg/L, then take actions to identify the source and remediate.

Note: Results are arranged in order of highest to lowest.

Figure 3. Example of 90 Percent Passing Rate after First Flush.

This is a 70 percent passing rate. Only seven out of 10 samples were ≤ 0.015 mg/L.

This is a 90 percent passing rate. Nine out of 10 samples (two from the 2nd flush and seven from the 1st flush) were ≤ 0.015 mg/L.

Consider taking actions at this location to identify and remediate the source of lead.

Flushing and Sampling Location	1st Flush Lead Result (mg/L)	2nd Flush Lead Result (mg/L)
Faucet B1 – 1st Floor	0.047	0.023
Faucet G3 – 3rd Floor	0.036	0.009
Faucet E2 – 2nd Floor	0.021	Not Detected
Faucet K3 – 3rd Floor	0.008	Not Tested
Faucet H3 – 3rd Floor	0.005	Not Tested
Faucet F2 – 2nd Floor	0.005	Not Tested
Faucet A1 – 1st Floor	Not Detected	Not Tested
Faucet C1 – 1st Floor	Not Detected	Not Tested
Faucet D2 – 2nd Floor	Not Detected	Not Tested
Faucet L3 – 3rd Floor	Not Detected	Not Tested

Note: Results are arranged in order of highest to lowest.

Figure 4. Example of a 90 Percent Passing Rate after Second Flush.

Variation of the Flushing, Sampling, and Testing Procedures

Provided adequate resources are available, a variation to these flushing, sampling, and testing procedures is to flush every faucet in the new building using the previously identified flushing procedure. Then, choose faucets for sampling using the guidance provided in the **Identification of Flushing and Sampling Locations** section. This variation will further reduce drinking water lead levels in the new building through improved flushing of brass particulates from the entire plumbing system and help establish protective films on all faucets and plumbing components to reduce lead leaching.

Identifying the Source of Lead

Introduction

When flushing alone does not result in achieving a 90-percent passing rate or does not result in achieving acceptable lead levels for specific sampling locations, additional steps need to be taken to identify the source and minimize the lead contributed by that source. Conducting a consecutive sampling event in conjunction with a detailed review of building plumbing schematics to identify brass plumbing components will pinpoint the source(s) of lead. In most cases, there will be in-line brass plumbing components (y-strainers, pressure reducing valves, shut-off valves) located upstream from the faucet that are contributing lead to the drinking water. Review the building plumbing schematics to see if any upstream plumbing devices are marked or identified then conduct a consecutive sampling event.

Conducting a Consecutive Sampling Event

- For each flushing and sampling location, remove the faucet aerator. Clean the aerator of debris, if visibly present, since this could be the source of lead.

- Fully open the faucet and flush at a high rate, long enough to obtain water from a pipe riser (in a multi-story building) or from the building service connection (for faucets located on the bottom/first floor or in a single-story building). Using building plumbing schematics, an estimated flushing time can be calculated based on piping diameters and lengths. In the absence of detailed schematics, choose an arbitrary time of 5–10 minutes. Figure 5 shows how to calculate flushing time.

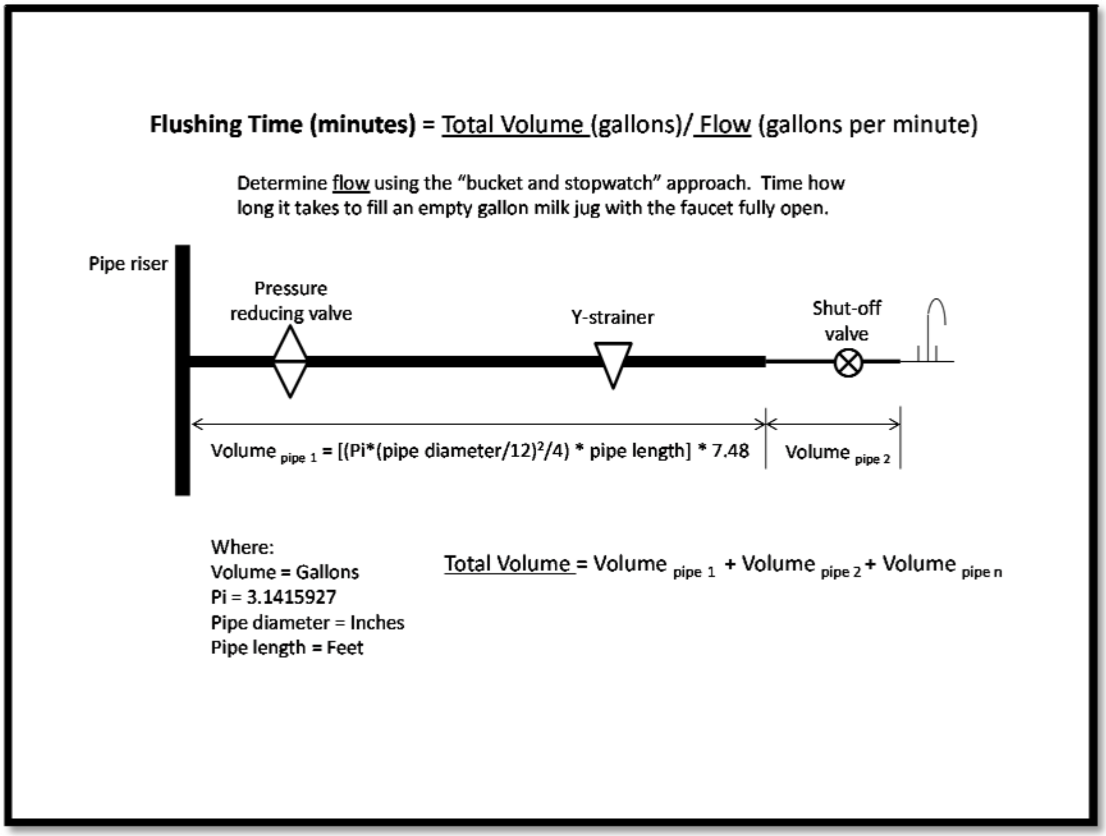

Figure 5. Calculation of Flushing Time

- After flushing, replace the faucet aerator and let the water sit unused for at least 6 hours, or overnight.

- Gently open the cold water faucet and immediately collect a 100-mL first draw sample. This smaller volume consists of water sitting in the faucet and brass components (e.g., shut off valve, compression fittings) connected to the faucet and immediately upstream of it.

- Once the first draw sample is taken, collect enough successive, 1-liter samples to capture water that sat unused in upstream, in-line brass plumbing components. Collect successive samples by gently opening the faucet to achieve a slow to moderate flow and filling a 1 liter sample container. When the bottle is full, turn off the faucet, cap the sample bottle and repeat. The number of samples can be estimated by using plumbing schematics and calculating water volumes from pipe lengths and diameters, as shown in the top example in Figure

6. In the event of large sample volumes (i.e., numerous 1 Liter samples), a variation to this step is to conduct a flush between samples, as shown in the bottom example in Figure 6. In the absence of detailed schematics, choose an arbitrary number of 1-liter samples, up to 10 samples.

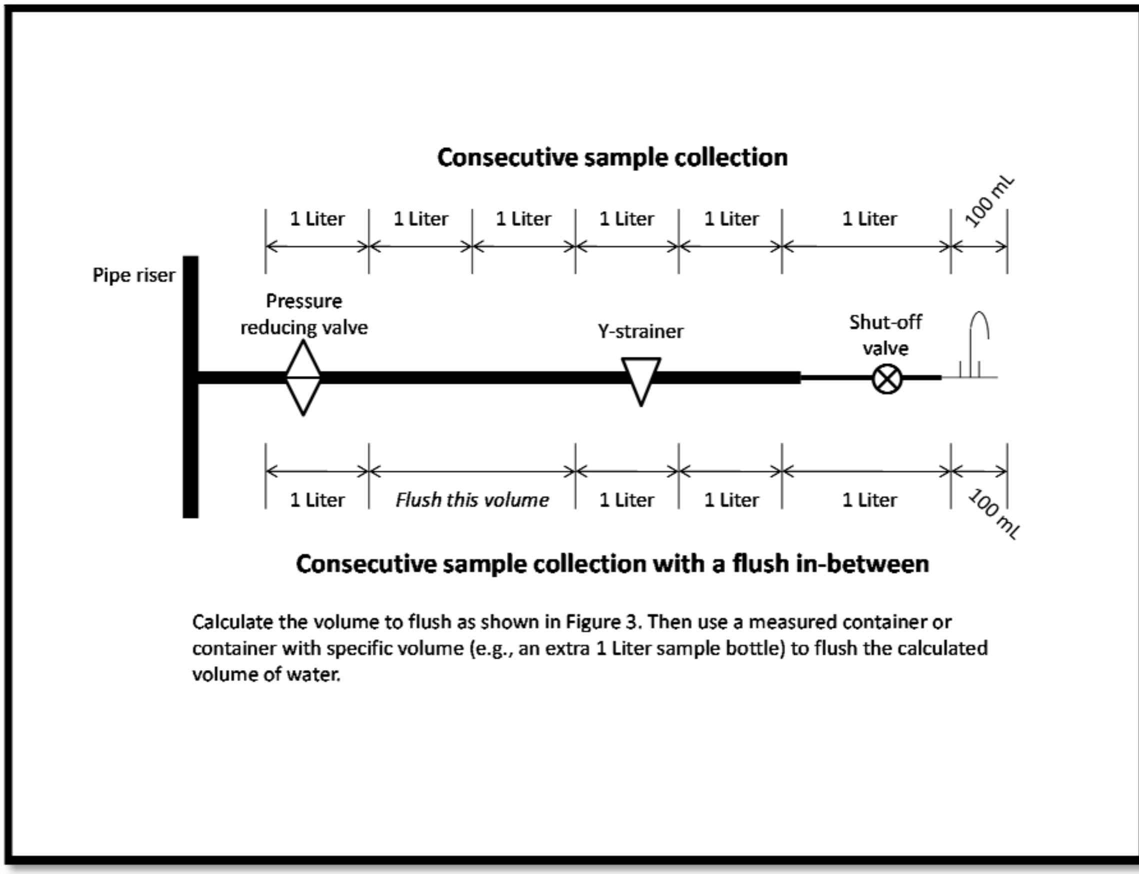

Figure 6. Examples of Consecutive Sampling and Flushing between Sampling

Data Analyses

All of the samples with water that sat unused in contact with a brass plumbing component will likely contain some amount of lead. Evaluate the data to identify those components contributing greater than 0.015 mg/L lead. Once identified, take remedial action on those components; either cleaning and/or replacement.

Remedial Actions

Cleaning Plumbing Components

If the identified plumbing component is a brass Y-strainer (Figure 7) or similar straining device (e.g., basket, or V-type strainer), shut off the water supply upstream of the strainer, then disassemble and examine the strainer. The strainer may have trapped brass shavings or particulates containing lead. Clean the strainer, re-assemble, then flush the faucet downstream of the strainer for 10-minutes at a high rate flush (with the faucet aerator removed), and conduct a follow-up sampling event using the consecutive sampling event procedure described earlier and collect three, 1-Liter samples; one sample just prior to the strainer, one sample containing water residing in the strainer, and one sample just after the strainer. This ensures a sample of the water residing in the strainer will be collected. If follow-up lead levels continue to be greater than 0.015 mg/L, then replace the strainer.

Source: http://www.bathroomfaucetsb2b.com/

Figure 7. Brass Y-strainer

Replacing Plumbing Components

If a Y-strainer or similar straining plumbing component continues to leach lead levels above 0.015 mg/L, or a different type of plumbing component is identified as a major contributor of lead (e.g., brass shut-off valve, pressure reducing valve, compression fittings), then replace with a certified low lead plumbing component. These components have been third party certified to contain equal to or less than 0.25 percent lead by weight. This is much less lead content than the current SDWA lead ban requirement of

less than or equal to 8.0 percent lead by weight. These components are certified through the NSF® Standard 61, Annex G testing process. Numerous manufacturers have many different plumbing components Annex G certified. Plumbing products certified to meet the low lead requirement will have one of the certification marks shown in Figure 8 on the product packaging. Low-lead plumbing products can also be found on the NSF product and service listings website: http://www.nsf.org/business/search_listings/. Navigate to the products by scrolling down and clicking on the "Lead Content Certification" link. Then, scroll down on the search page and click the box labeled "Drinking Water System Components (NSF/ANSI Std. 61 including Annex G)". Clicking the search button provides a listing of manufacturers with certified components, and clicking on a manufacturer will show a listing of their specific certified components. After component replacement, flush the faucet downstream of the newly installed component using the guidelines in the **Flushing Procedure** section.

Figure 8. NSF/ANSI Standard 61, Annex G Certification Marks

SUMMARY

Ensuring acceptable water quality in new buildings is essential to maintaining public health and mission success. There have been several recent incidents where elevated levels of lead in drinking water were identified in newly constructed buildings. These elevated lead levels pose a public health threat. The following flowchart (Figure 9) summarizes guidance and recommended actions outlined in this information paper to reduce drinking water lead levels in new buildings. Implementing these actions will minimize the lead health risk and help ensure acceptable water quality in new building plumbing systems prior to occupancy.

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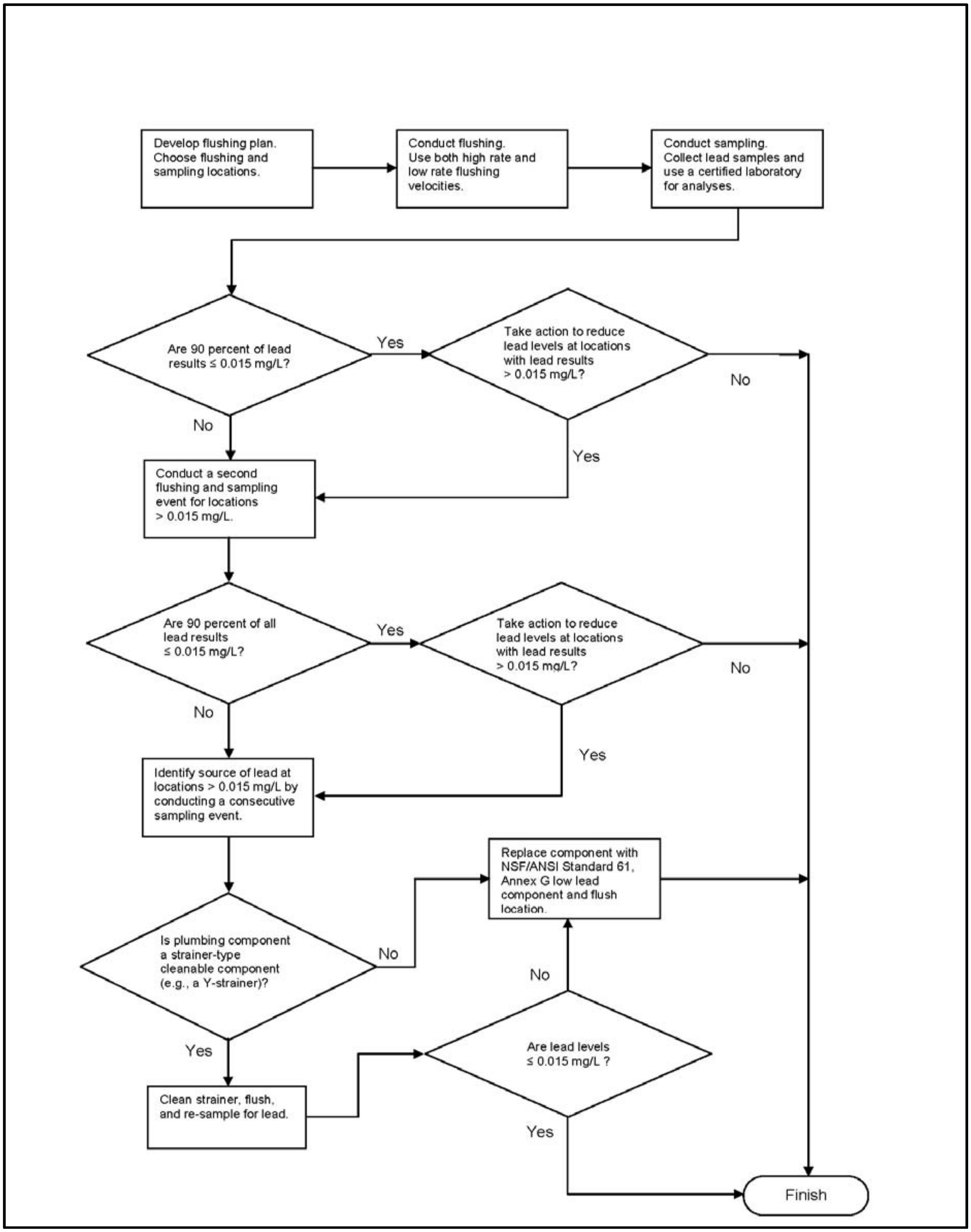

Figure 9. Flowchart for Lead Reduction in New Building Plumbing Systems

APPENDIX
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